Chapter 25
Open Burn/Open Detonation

25-1. General

The process, applications, and possible toxic effects of open burn/detonation are described in the chapter's first section. The second portion of the chapter is a hazard analysis with controls and control points listed.

25-2. Technology Description

a. Process.

Explosives may be encountered as a part of remedial actions, particularly at military and industrial sites. In many circumstances, the safest or only method for the safe disposal of these materials is by burning or detonation in open pits.

Open burning/detonation uses an excavated and usually bermed burn/detonation pit in which explosives of various classes can be burned or detonated. The pit, usually excavated to a depth of 6 to 10 feet, is typically ramped on one side to permit entry. Berms provide added containment while burning or detonating. Pits with vertical walls tend to contain blasts, forcing the released energy to be expelled vertically. However, some open burn/detonation are more pan-like in their design, with wide flat shallow sides, and blast energy radiates evenly outward on all sides. Pan-styles are better suited to open burning to enhance oxygen support to the waste material. Pan-style open burning/detonation pits are less suited to detonation in areas where space in limited, owing to the wider safety zone needed around the pit's circumference. Some pan-type detonation designs include half lids or hinged sides designed to contain blasts. The material for burning (including burnable explosives) or detonation is pumped or placed into the pit. Then material is ignited or detonated from a distance by electrical or ignitable fuses or detonators, signal fuses, torch, or other ignition/initiator sources. Good safety practices dictate electrical ignition whenever possible. In the case of burning explosives, an accelerant fuel, such as fuel oil or other readily combustible material, may be poured onto the explosives to easily initiate the burn. Also included for detonations may be a primary explosive to make the explosion more efficient and complete. The contents of the pit are allowed to burn in the confined space until the burning/detonation is complete. See Figure 25-1 for an illustration of the process in simple form.

The pit may be emptied of residue between burnings/detonations or after a sequence of burnings/detonations. Burning or detonating batches of material in sequence can be highly dangerous as the operator must be certain that all burning/detonation is complete, and no premature ignition sources remain in the pit during reloading of the flammable/explosive wastes.

The operator needs a complete understanding of the age, state, and nature of the explosives or other materials to be destroyed, as well as other chemicals present. Many

explosive material properties are radically different when burned or detonated in large masses versus small (e.g., large, burning masses of TNT may self-detonate while small amounts burn safely). An operator should be able to recognize certain metals, oxidizers, or reducers, know when material is partially melted, recognize aged or partially decomposed substances (e.g., picric acid), or a variety of other conditions.

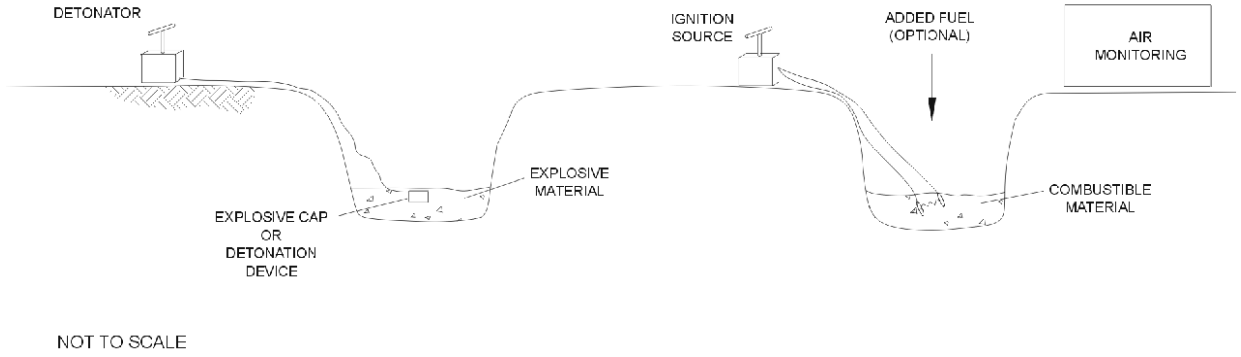

FIGURE 25-1. OPEN BURN/OPEN DETONATION

b. Applications.

Explosives include propellants, high and low explosives, many of which will burn or explode, and various initiators, ignitors, detonators, and accelerants. Included in these categories are dynamite, nitroglycerin, HMX, RDX, TNT, PETN, and Tetryl, mercury and other metal fulminates, styphnates, lead and other metal azides, ammonium nitrate, black powder, picric acid, and derivatives (such as salts) of the above.

c. Toxic Effects.

Most explosives such as TNT, RDX, picrates, HMX, tetryl, dynamite, and lead azides can have toxic effects or produce materials with toxic effects when burned or exploded. Examples of materials released or produced include unreacted explosives such as nitroglycerin and TNT, heavy metals such as mercury, lead or silver, cadmium, salt products, nitrogen oxide, and other nitrogenous residues with potential toxicity.

25-3. Hazard Analysis

Principal unique hazards associated with open burn/open detonation, methods for control, and control points are described below.

a. Physical Hazards.

(1) *Ignition Systems.*
Description. Burning ignition systems may not reliably ignite the waste material. The wick or flame used to ignite the waste material may be temporarily extinguished by moisture or wind, only to reignite shortly thereafter. The delay in ignition may cause workers to believe the burning ignition system has failed. As they approach the burn area to investigate, detonation may occur.

Control. Controls for ignition systems include:
- Provide proper training and experience for personnel. This is critical.
- Design and construct reliable, remote, intrinsically safe ignition systems as a requirement for operation.

CONTROL POINT: Design, Construction, Operations, Maintenance

(2) *Quantity, Type of Explosives.*
Description. An explosion may damage the pit construction and injure any workers in the vicinity if more than the design quantity or type of explosives is detonated in one charge.

Control.. Controls for quantity and type of explosives include:
- Know quantities and types of explosives for the open burn/detonation pit design type and never exceed limits.
- Follow control procedures rigorously.
- Evenly distribute explosive wastes. Uneven distribution can create an excessive density of explosive material, resulting in uncontrolled explosive conditions.

CONTROL POINT: Operations

(3) *Pit Entry.*
Description. Sharp and hot fragments and residue may be present when entering the pit after prior burns or detonations. Workers may also be exposed to potential wall collapse or confined-space entry hazards.

Control. Controls for pit entry include:
- Wear appropriate personal protective equipment (PPE).
- Shore walls to prevent collapse.
- Require a structural inspection by a competent person prior to each pit entry.

CONTROL POINT: Design, Construction, Operations

(4) *Handling Waste Materials.*
Description. Hazards inherent in open burn and open detonation techniques may involve the handling of unstable waste materials, such as unusable munitions and explosive materials. Workers handling these materials face the risk of

these materials auto-detonating, especially if the explosives have become unstable because of age or other factors.

Control. Controls for handling waste materials include:

- Use only persons specifically trained in detonation and disposal techniques to transport and handle materials.
- Consult the Ordnance and Explosive Waste (OE) Center of Expertise (CX), Huntsville, Alabama, prior to any handling or movement of explosive items or of soils/materials significantly contaminated with explosives.

CONTROL POINT: Operations

(5) *Structures at or Near Detonation*.

Description. One or repeated explosions may cause mortar deterioration or fragmentation of concrete or cinder block walls of buildings or structures at or near the detonation area, particularly if large quantities of explosive materials are detonated.

Control. Controls for damage to structures nearby include:

- Limit the amount of waste materials detonated at any one time based on the known effects of the explosives.
- Consider using seismic monitoring of critical structures during the controlled detonation of the explosives.
- Divide large volumes of wastes and detonate in a series of smaller explosions.
- Locate the treatment facility carefully so that sensitive structures are not present or nearby.
- Design structures for shelter or containment of the explosions or burnings to adequately withstand the expected use of the system.

CONTROL POINT: Design, Operations

(6) *UV Radiation*.

Description. During site activities, workers may be exposed to direct and indirect sunlight and the corresponding ultraviolet (UV) radiation. Even short-term exposure to sunlight can cause burns and dermal damage. Hot and humid conditions may also result in heat stress, which can manifest itself as heat exhaustion and heat stroke.

Control. Controls for UV radiation include:

- Minimize direct sun exposure by wearing sun hats, long-sleeved shirts, full-length pants, and by applying UV barrier sunscreen. All UV skin barrier creams should be pre-approved. Some creams contain zinc and other constituents that can cause false readings in analytical samples.
- Shade work and break areas, if possible.

- Minimize exposure to heat stress conditions by taking frequent breaks, drinking adequate fluids, and working during the early morning and late afternoon hours.
- Monitor for heat stress using the physiological or Wet Bulb Globe Temperature (WBGT) Index protocol provided in the most recent publication of the American Conference of Governmental Industrial Hygienists (ACGIH) "TLVs and BEIs: Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices."

CONTROL POINT: Construction, Operations

(7) *Blast Noise Pressure.*
Description. Workers may be exposed to high impact noise pressure from the detonation. Even short-term exposure to high impact or explosion noise pressure can cause permanent hearing loss.

Control. Controls for high noise pressure include:

- Provide adequate distance from the explosion noise source in the burn/detonation pit based on the formula for Sound Pressure Level (SPL) as a function of distance from a point source, such that the distance will reduce impulse/impact sound pressure "at the ear" to levels preventing hearing loss or damage without the use of engineering controls (<140 dB impact noise (Peak)).
- Install noise pressure impact reducing barriers. Allow detonation only after workers are moved to safe zones or barriers proximate to the impact noise detonation sources.
- Use personal protective hearing devices including use of duel protection of plugs plus muffs.
- Establish and adhere to a hearing conservation program for the detonation workers. See DoD 6055.12 - 1996: "DoD Hearing Conservation Program".
- Train workers in the noise hazards of detonation.

CONTROL POINT: Design, operations

(8) *Continuous Noise Pressure.*
Description. Workers may be exposed to high continuous noise pressure from heavy equipment operations related to construction of the detonation pits. Unprotected, workers can suffer permanent hearing loss from the equipment noise.

Control. Controls for high noise pressure include:

- Allow only workers essential to the operation of the heavy equipment in the operation areas. Distance other on-site workers from the noise sources based on the formula for Sound Pressure Level (SPL) as a function of distance from a point source, such that the distance will reduce sound

pressure “at the ear” to levels preventing hearing loss or damage without the use of engineering controls.

- Use personal protective hearing devices with total allowable NRR ratings to reduce the A-weighted sound pressure levels to within acceptable levels based on federal regulations while maintaining personal communication abilities (avoid significant over protection and consider using hearing protection with integrated communication devices for the equipment operators and ground spotters).
- Establish and adhere to a hearing conservation program for the detonation workers. See 29 CFR 1910.95, 29 CFR 1926.101 and DoD 6055.12.
- Train workers in the noise hazards of heavy equipment operation.

CONTROL POINT: Design, operations

(9) *Design Field Activities.*

Description. Design field activities associated with subsequent construction may include surveying, biological surveys, geophysical surveys, trenching, stockpiling, contaminated groundwater sampling, and other activities. Each of these field activities may expose the survey personnel to physical, chemical, biological, or radiological hazards.

Control. Controls for hazards resulting from design field activities include:

- Prepare an activity hazard analysis for design field survey activities. EM 385-1-1, Section 1, provides guidance on developing an activity hazard analysis.
- Train workers in hazards identified.

CONTROL POINT: Design

b. Chemical Hazards.

(1) *Residual Cadmium, Crystalline Silica or Other Material.*

Description. Significant exposures to residual soil cadmium or crystalline silica among heavy equipment operators is possible during trench excavations at the demolition location, especially during high heat and dry ambient conditions that greatly increase the creation of fugitive dust. Cadmium, used as a plating to prevent corrosion of steel bomb casings, can accumulate as an explosion byproduct in the soil. On rare occasions some bombs may contain an asbestos-tar matrix used as an internal coating. Repeated use of the same location for bomb detonation tends over time to pulverize the soil particles, including naturally occurring crystalline silica (sand) into fine dust, creating a respirable dust hazard to the equipment operators.

Control. Controls for residual cadmium, respirable crystalline silica or other materials:

- Train the site workers in the hazards associated with inhalation of cadmium or respirable crystalline silica or asbestos.
- Do not operate multiple pieces of heavy trenching equipment down wind of each other.
- Whenever possible, take advantage of ambient moisture and wind conditions to minimize the creation and stagnation of fugitive dust during trenching operations.
- Use water spray or other wetting agents from tank trucks to treat the detonation location before and during trenching to reduce fugitive dust emissions.
- Equip heavy equipment operators with appropriate N, R or P 100 particulate filter air purifying respirators (APRs) or air-supplied respirators to control the inhalation hazard created by the fugitive dust. Institute a respiratory protection program that accounts for the characteristics of the fugitive dust.
- Use laundered work clothing or permeable disposable work clothing that minimizes the risk of heat stress, in conjunction with work-site shower and clean changing facilities for all site workers.

CONTROL POINT: Operations

(2) *Residual or Untreated Material*.
Description. If detonation or burning fails to fully neutralize the material, workers entering the burn pit may be exposed to it. Unreacted material may be carried downwind, exposing workers in the area. Heavy metal primer materials (metal azides and lead, mercury or silver compounds) and residual explosive components (e.g., nitroglycerin) may cause heart arrhythmias, headaches, and other physical effects.

Control. Controls for residual or untreated material include:
- Remain upwind of the pit during burning and detonations.
- Use PPE, as determined by a qualified health and safety professional, when entering the pit after burning and explosions. Examples of appropriate PPE include steel shank boots, coveralls to protect from dermal contact, nitrile or butyl gloves if soil handling is expected, and an appropriate air-purifying respirator if fumes or smoke are present.
- Use experts in detonations and burning, including accelerants or fuels or initiator explosives, to assure the maximum explosive/waste consumption.

CONTROL POINT: Design, Operations

(3) *Pit Atmospheric Conditions*.
Description. Workers who enter the pit may be exposed to an oxygen deficient atmosphere, to airborne toxic materials or carbon monoxide from the persistence of gases generated from subsurface blasting operations. A special

case involves the presence of liquid fuel storage facilities at the site that could contribute to confined space toxic atmospheres.

Control. Controls for pit atmospheric conditions include:

- Test the atmosphere within the trench to determine the level of airborne toxins, carbon monoxide, and oxygen level prior to entry (see 29 CFR 1910.146).
- Follow confined-space entry protocols, which may necessitate the use of PPE such as an air-purifying respirator equipped with an organic vapor cartridge, a supplied-air respirator or self-contained breathing apparatus (SCBA).

CONTROL POINT: Operations, Maintenance

c. Radiological Hazards.

No unique hazards are identified.

d. Biological Hazards.

Description. If used infrequently or located in wooded or remote areas, snakes, including poisonous snakes, may use the open pan-type burn-detonation areas for sun bathing. This occurs particularly in spring and fall when there are significant temperatures variations between day and night. Care must be taken on first walking up to remote, infrequently used open pan-type burn areas.

Control. Controls for open burn pit/detonation biological hazards include:

- Visually inspect pit area for wildlife prior to bringing material, particularly shock sensitive materials, to the open burn/detonation area.
- Prepare to chase wildlife out of the open burn/detonation area from a distance using loud noises, stomping, or tossing non-hazardous debris in their area.
- Do not attempt to manually remove any wildlife without proper training and equipment. Call for specialized assistance from departments of natural resources or similar wildlife specialists.
- Do not burn or detonate wildlife.

CONTROL POINT: Operations, Maintenance